that knowledge which enables us to sort the things known according to their true relations. On this ground we call Haller the father of physiology, because, regardless of existing theories, he brought together into a system all that was then known by observation or experiment as to the processes of the living body. But in the "Elementa Physiologiæ" we have rather that out of which science springs than science itself. Science can hardly be said to begin until we have by experiment acquired such a knowledge of the relation between events and their antecedents, between processes and their products, that in our own sphere we are able to forecast the operations of nature, even when they lie beyond the reach of direct observation. I would accordingly claim for physiology a place in the sisterhood of the sciences, not because so large a number of new facts have been brought to light, but because she has in her measure acquired that gift of prevision which has been long enjoyed by the higher branches of natural philosophy. In illustration of this I have endeavored to show you that every step of the laborious investigations undertaken during the last thirty years as to the process of nutrition, has been inspired by the provisions of J. R. Mayer, and that what we have learnt with so much labor by experiments on animals is but the realization of conceptions which existed two hundred years ago in the mind of Descartes as to the mechanism of the nervous system. If I wanted another example I might find it in the provisions of Dr. Thomas Young as to the mechanism of the circulation, which for thirty years were utterly disregarded, until, at the epoch to which I have so often adverted, they received their full justification from the experimental investigations of Ludwig.

But perhaps it will occur to some one that if physiology founds her claim to be regarded as a science on her power of anticipating the results of her own experiments, it is unnecessary to make experiments at all. Although this objection has been frequently heard lately from certain persons who call themselves philosophers, it is not very likely to be made seriously here. The answer is, that it is contrary to experience. Although we work in the certainty that every experimental result will come out in accordance with great principles (such as the principle that every plant or animal is both, as regards form and function, the outcome of its past and present conditions, and that in every vital process the same relations obtain between expenditure and product as hold outside of the organism), these principles do little more for us than indicate the direction in which we are to proceed. The history of science teaches us that a general principle is like a ripe seed, which may remain useless and inactive for an indefinite period, until the conditions favorable to its germination come into existence. Thus the conditions for which the theory of animal automatism of Descartes had to wait two centuries, were (1) the acquirement of an adequate knowledge of the structure of the animal organism, and (2) the development of the sciences of physics and chemistry; for at no earlier moment were these sciences competent to furnish either the knowledge or the methods necessary for its experimental realization; and for a reason precisely similar Young's theory of the circulation was disregarded for thirty years.

I trust that the examples I have placed before you to-day may have been sufficient to show that the investigators who are now working with such earnestness in all parts of the world for the advance of physiology, have before them a definite and well-understood purpose, that purpose being to acquire an exact knowledge of the chemical and physical processes of animal life, and of the self-acting machinery by which they are regulated for the general good of the organism. The more singly and straightforwardly we direct our efforts to these ends, the sooner we shall attain to the still higher purpose—the effectual application of our knowledge for the increase of human happiness.

The Science of Physiology has already afforded her aid to the Art of Medicine in furnishing her with a vast store of knowledge obtained by the experimental investigation of the action of remedies and of the causes of diseases. These investigations are now being carried on in all parts of the world with great diligence, so that we may confidently anticipate that during the next generation the progress of pathology will be as rapid as that of physiology has been in the past, and that as time goes on the practice of medicine will gradually come more and more under the influence of scientific knowledge. That this change is already in progress we have abundant evidence. We need make no effort to hasten the process, for we may be quite sure that, as soon as science is competent to dictate, art will be ready to obey.

METEORIC DUST.

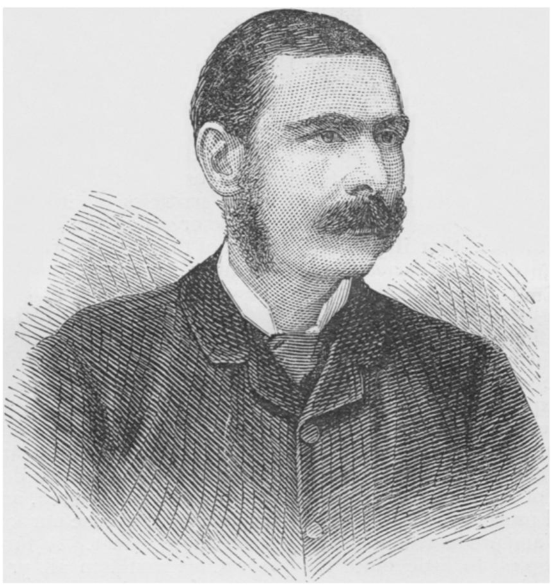
By Prof. Schuster.

A committee of the British Association was appointed for the double purpose of examining the observations hitherto recorded on the subject of meteoric dust and of discussing the possibility of future more systematic investigations. With regard to the first point we note that in a paper presented to the Royal Astronomical Society in 1879, Mr. Ranyard has given what appears to be a pretty complete account of the known observations as to the presence of meteoric dust in the atmosphere. It appears that in the year 1852 Prof. Andrews found native iron in the basalt of the Giant's Causeway. Nordenskjöld found particles of iron which in all probability had a cosmic origin in the snows of Finland and in the ice-fields of the Arctic regions. Dr. T. L. Phipson, and more recently Tissandier, found similar particles deposited by the winds on plates exposed in different localities. Finally, Mr. John Murray discovered magnetic particles raised from deposits at the bottom of the sea by H. M. S. *Challenger*. These articles were examined by Prof. Alexander Herschel, who agreed with Mr. Murray in ascribing a cosmic origin to them. For fuller details and all references we must refer to Mr. Ranyard's paper. There cannot be any doubt that magnetic dust, which in all probability derives it origin from meteors, has often been observed, and the question arises, in what way we can increase our knowledge on these points to an appreciable extent. A further series of occasional observations would in all probability lead to no result of great value, unless they were carried on for a great length of time in suitable places. Meteoric dust, we know, does fall, and observations ought if possible to be directed rather towards an approximate estimate of the quantity which falls within a given time. Difficulties very likely will be found in the determination of the locality in which the observations should be conducted. The place ought to be sheltered as much as possible against any ordinary dust not of meteoric origin. The lonely spots best fitted for these observations are generally accessible to occasional experiments only, and do not lend themselves easily to a regular series of observations. Nevertheless experiments continued for a few months at some elevated spot in the Alps might lead to valuable results. The Committee would like to draw attention to an instrument which is well fitted for such observations. It was devised by Dr. Pierre Miquel for the purpose of examining, not the meteoric particles, but organic and organized matters floating about in the air. A description, with illustrations, will be found in the *Annuaire de Montsouris* for 1879. Two forms of the instrument are given. In the first form, which is only adapted to permanent places of observations, an aspirator draws a quantity of air through a fine hole. The air impinges on a plate coated with glycerine, which retains all solid matter. By means of this instrument we may determine the quantity of solid particles within a given volume of air,

The second, more portable form, does not allow such an accurate quantitative air analysis. The instrument is attached to a weathercock, and thus is always directed against the wind, which traverses it, and deposits, as in the other permanent form, its solid matter on a glycerine plate. An anemometer placed in the vicinity serves to give an approximate idea of the quantity of air which has passed through the apparatus. These instruments have been called aëroscopes by their inventor. It is likely that the second form given to the apparatus will be best fitted for the purpose which the Committee has in view.

THE NEW ASTRONOMER ROYAL.

Mr. William Henry Mahony Christie. who has succeeded Sir George Airy in the office of Astronomer Royal at the Royal Observatory, Greenwich Park, was born on October 1, 1845, at Woolwich. He is a younger son of the late Professor S. H. Christie, of the Royal Military Academy, Woolwich, and formerly Secretary to the Royal Society. Mr. W. H. M. Christie was educated at Kings College School, London; and at Trinity College, Cambridge, which he entered in 1864, having won a Minor's Scholarship of that College; he subsequently gained a Foundation Scholarship and was afterwards elected a Fellow of Trinity College. He took his degree of B.A. in 1868, as fourth wrangler in the Mathematical Tripos, and in 1871 proceeded to the M. A. degree. In 1870, Mr. Christie was appointed Chief Assistant at the Royal Observatory; and he has, during the past ten years, done special good service by contriving and introducing several valuable improvements in the scientific apparatus there in use; a new form of spectroscope, an instrument for determining the colors and brightness of the stars, a recording micrometer, and a polarising solar eye-piece, are to be mentioned as his inventions. In the recent address of the President of the British Association, at York, a passing reference was made to Mr. Christie's work in verifying the results obtained by Dr. Huggins, with regard to the motions of stars, as inferred from spectroscopic observations. The new Astronomer Royal has directed particular attention, at the Royal Observatory, both to spectroscopy and to photography, as a means of recording the observations. He is a fellow of the Royal Society, and was elected Secretary of the Royal Astronomical Society last year. He contributed to the proceedings of the Royal Society, in March, 1877, a paper "on the magnifying power of the half-prism, as a means of obtaining great dispersion, and on the general theory of the half-prism spectroscope." To the monthly notices of the Royal Astronomical Society, he has furnished these: in June, 1873, a paper on the recording micrometer; in January, 1874, on the color and brightness of stars, as measured with a new photometer; in May, 1875, on the determination of the scale in photographs of the Transit of Venus; in 1876, (January) on a new form of solar eye-piece; (May) on the displacement of lines in the spectra of stars; (November) on the effect of wear in the micrometer screws of the Greenwich Transit Circle; same year (December) on the gradation of light on the disk of Venus; in 1878 (January) on specular reflection from Venus; (June) on the existence of bright lines in the solar spectrum; in 1879 (January) on a phenomeno seen in the occultation of a star by the moon's bright limb; in 1880, November, on the spectrum of Hartwig's comet of that year; in 1881 (January) on Mr. Stone's alterations of Bessel's refractions; (May) on the flexure of the Greenwich transit circle, and some further remarks on Mr. Stone's alterations of Bessel's refractions; besides various papers on the Greenwich spectroscopic and photographic observations, communicated by the late Astronomer Royal; and a paper which will be found in the Memoirs of the Royal Astronomical Society, published in January, 1880, on the systematic errors of the Greenwich North Polar distances. Mr. Christie is also the founder and editor of a journal entitled "*The Observatory*, a Monthly Review of Astronomy," which has been published during the past four years; and he is author of the "Manual of Elementary Astronomy," published in 1875 by the Society for Promoting Christian Knowledge.



WILLIAM H. M. CHRISTIE.

ON THE ELECTRIC CONDUCTIVITY AND DICHROIC ABSORPTION OF TOURMALINE.*

By Prof. SILVANUS P. THOMPSON.

The electric conductivity of tourmaline differs in different directions; being, according to the author's experiments, a minimum along the optic axis. Tourmaline also possesses the optical property of dichroism, its absorption being a maximum for rays parallel to the axis, and greater for blue rays than for red, equal thicknesses of crystal being considered. According to the electro-magnetic theory of light, bodies which are good conductors of electricity should be opaque to light. The author has in the August number of the *Philosophical Magazine* rewritten the equations of Maxwell's electro-magnetic theory for the case of crystalline media possessing different conductivities in different directions. From these equations it appears that in tourmaline and negative uniaxial crystals electric displacements at right angles to the axis will be more absorbed than electric displacements parallel to the axis. This accounts for the well-known greater absorption of the ordinary ray, provided the views of Stokes and Fresnel are correct, that these displacements are at right angles to the so-called plane of polarization. The difference of velocity between the rays of different color accounts for the difference of absorption being greater in that direction in which the conductivity is a minimum. It was also pointed out that in positive uniaxial crystals, in which the electric conductivity is a maximum along the axis, there will be maximum absorption of the extraordinary ray, and there will be least opacity along the axis. Smoky quartz and magnesic platinocyanide fulfil the latter condition. Specimens of tourmaline cut into cubes to show the colors in different directions were shown, and also specimens of magnesic platinocyanide and of herapathite. Mechanico-optical models were also shown illustrating the theory; a tourmaline being represented by a cube built up of layers of glass and wire-gauze. In conclusion it was shown that crystals in which the electric conductivity differs in three different directions will exhibit *trichroism;* and that di- or trichroic absorption is a general property of all colored crystals other than those of the cubical system.

* British Association, 1881.